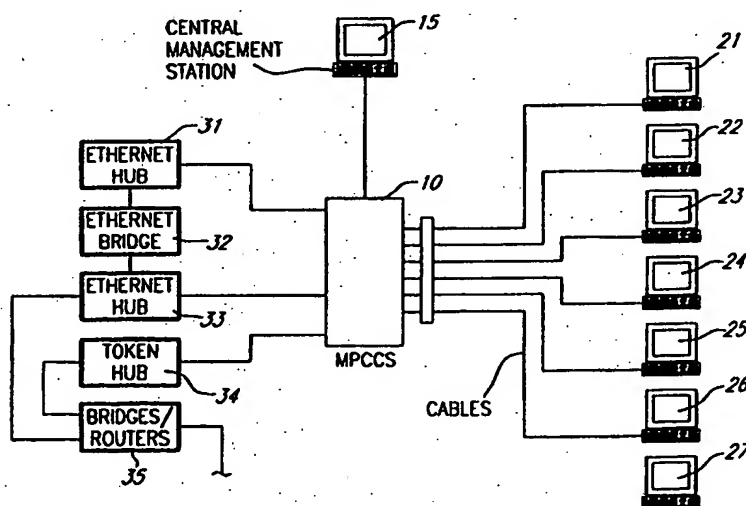




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶: H04L 12/44, 29/06, H04Q 1/14	A1	(11) International Publication Number: WO 98/28883 (43) International Publication Date: 2 July 1998 (02.07.98)
(21) International Application Number: PCT/CA97/00985 (22) International Filing Date: 19 December 1997 (19.12.97) (30) Priority Data: 08/771,979 23 December 1996 (23.12.96) US (71) Applicant: NORDX/CDT., INC. [CA/CA]; 2345 Boulevard des Sources, Pointe-Claire, Quebec H9R 5Z3 (CA). (72) Inventors: LAMARCHE, François; 90 Patrick McGee, Laprairie, Quebec J5R 5L3 (CA). GAUTHIER, John; 2594 Toulouse Street, Mascouche, Quebec J7K 1K2 (CA). (74) Agents: ANGLEHART, James et al.; Swabey Ogilvy Renau, Suite 1600, 1981 McGill College Avenue, Montreal, Quebec H3A 2Y3 (CA).		(81) Designated States: AU, CA, CN, JP, MX, SG, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: NETWORK INCLUDING MULTI-PROTOCOL CROSS-CONNECT SWITCH



(57) Abstract

The present invention relates to a cross-connect switch which allows different protocols to be used. The switch is made up of two cross point modules, one for transmission and one for reception. I/O blocks corresponding to each station or network interface are connected to the cross point modules. Each I/O block includes four differential pairs. The I/O block permits selective activation for transmission or reception of any of the four pairs. In addition, half duplex control logic is used to implement protocols using a single differential pair for both transmission and reception. Also a token ring interface is included on the I/O blocks in order to allow detection and generation of phantom DC currents necessary for operation with token rings.

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NETWORK INCLUDING MULTI-PROTOCOL CROSS-CONNECT SWITCH

Field of the Invention

The present invention relates to cross-connect
5 switches for use in data networks. In particular, it
relates to a cross-connect switch which can connect
computers to various networks using different protocols.

Discussion of the Related Art

10 Computer networks have expanded greatly in terms of
numbers of computers connected to a network and the types
of networks which exist. In fact, a single computer may
be part of several networks with different capabilities.
Networks also have various numbers of computers, from
15 work groups, to local area networks, wide area networks,
and global networks, such as the Internet and world wide
web. With so many types of networks created by various
companies, different protocols are used for
communications. Examples of these protocols include RS
20 232, Ethernet, Fast Ethernet, Token Rings, and ISDN.
These protocols not only require special communications
software, but also have specific hardware connection
requirements. The hardware connection requirements
necessitate various interconnections between computers,
25 servers, routers and other physical equipment in order to
implement the selected protocols and communications.

In order to provide the necessary connections,
offices are now wired for computer network connections.
Typically, cables run horizontally across a floor to
30 interconnect the computers on that floor. Various
networking equipment, such as routers, hubs and bridges,
are located within a wiring closet on the floor. The
networking equipment in the wiring closets on different
floors are interconnected with vertically running cables.
35 The horizontal cables typically terminate at a patch
panel within the wiring closet. The networking equipment
also terminate in a patch panel. To provide a specific

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computer with a connection to the network, the appropriate locations within the patch panels are interconnected with patch cords.

When a user changes locations, the physical
5 interconnections must also be changed to provide the user with access to the same network equipment. Frequent changes in workforce and work space has resulted in significant changes to networks. These changes require multiple accesses to the interconnections, and
10 complicated interconnections. Such changes also increase the costs of maintaining a network and are likely to cause more frequent faults. Therefore, a need exists for a system which allows automated interconnections of computers and networks.

15 Several different systems have been proposed for automating connections in a wiring closet through the use of cross connect switches. However, each of these systems include protocol specific hardware for making the connections. Thus, if a single network is used, the
20 computers can be easily rearranged; but if more than one network is part of the system, as in today's multi-protocol corporate data networks, automated changes in configurations are not possible. Plug-in cards (or equivalent hardware) of various types are used to
25 interconnect the computers. Each plug-in card is designed for a specific communication protocol. When a computer is to be connected to a different network, the plug-in card for that computer has to be changed. Therefore, a need exists for an automated interconnection
30 system which can operate with different protocols.

Summary of the Invention

The present invention in great part overcomes the deficiencies of existing interconnection systems by
35 providing a cross-connect switch which is operable with different protocols. According to one aspect of the invention, each device is connected to the

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interconnection system by programmable input/output (I/O) blocks. The I/O blocks include circuitry for executing different types of connections. Each I/O block has four differential pair inputs or outputs. The I/O block can
5 use any set of these pairs, so as to accommodate different network protocols on different pairs.

According to another aspect of the invention, the I/O blocks provide for selective termination of each of the differential pairs. According to another aspect of
10 the invention, the I/O blocks include circuitry to account for phantom current, half-duplex operation, and insertion losses.

According to another aspect of the invention, the I/O blocks are connected together through two crosspoint
15 modules, one for transmission and one for reception. An output of each distribution side I/O block is connected to the transmit crosspoint module, and an input to the receive crosspoint module. The I/O blocks on the equipment side of the switch are connected to the
20 crosspoint modules in reverse. Thus, by appropriately setting the connections in the cross point module, each computer on the distribution side can be connected to the appropriate network equipment on the equipment side. The crosspoint modules can be implemented as analog switches
25 or digital routers, with sufficient bandwidth to accommodate different protocols.

Brief Description of the Drawings

Fig. 1 illustrates a computer system including the
30 multi-protocol cross connect switch of the present invention.

Fig. 2 illustrates a physical embodiment of the present invention.

Fig. 3 is a block diagram illustrating an embodiment
35 of the present invention.

Fig. 4 is a block diagram illustrating portions of an I/O block according to an embodiment of the present

invention.

Fig. 5 is a block diagram illustrating half duplex control in the present invention.

Figs. 6A and 6B are schematics illustrating token ring termination according to an embodiment of the present invention.

Detailed Description

Fig. 1 illustrates the connections in the computer system utilizing the multi-protocol cross connect switch of the present invention. A multi-protocol cross connect switch 10 is connected on a distribution side to a variety of computers 21-27. On an equipment side, the cross connect switch 10 is connected to different types of networking interfaces, such as Ethernet hubs 31, 33 or a token ring hub 34. The interconnection interfaces may be connected together or connected to other interfaces at different locations through an Ethernet bridge 32 or other types of bridges or routers 35. The cross connect switch operates to connect each of the computers 21-27 to one of the interconnection interfaces 31-35 so that the computer is operating on a network. A central management station 15 is connected to the cross connect switch 10 in order to control the connections within the cross connect switch.

Fig. 2 illustrates a physical embodiment of the present invention. As illustrated in Fig. 2, the cross connect switch 10 can be implemented as a set of cards which fit into an equipment rack. The rack can be designed to be installed in a standard 19 inch rack for interconnections with the networking interfaces. As illustrated in Fig. 2, the equipment rack can accommodate a variety of cards which implement the cross connect switch. Access cards 110 each include connections for up to 18 ports 121. The 19 inch rack can accommodate up to 6 distribution access cards and 6 equipment access cards. The access cards terminate four differential pairs on

each port 121. As discussed below, typically two pairs in each port are switched through the system. Two cross point modules 130, 135 implement a switching fabric of 108 x 108 x 2 pairs. A main controller card 140 controls the access and crosspoint module cards. The main controller card also is an interface to the system software. An optional test card 150 is used to test the cables attached to the system. It can measure cable length, noise and impedance, and find miswires, cut and shorted cable. This information can then be sent to the central management station 15 through the main controller card 140. The system operator is thereby alerted to the equipment problems.

Fig. 3 illustrates, in a block format, the components of the cross connect switch 10 according to an embodiment of the present invention. An input/output (I/O) block 210 is connected to each port 121 of the cross connect switch 10 for the distribution side. A second I/O block 220 is connected to each port on the equipment side. Two cross-point modules 230, 240 are used to interconnect the I/O blocks on the distribution side 210 and equipment side 220. The crosspoint modules can be analog switches or digital routers. According to a preferred embodiment, analog switches are used. Digital routing methods use techniques such as time division multiplexing on an internal master digital bus. Under the current state of the technology, digital routing has a number of drawbacks in a high speed multi-protocol environment. For example, bandwidths of several hundred gigahertz are required to be supported by the master digital bus if one is to support several tens of ports with protocols up to 125 megabits per second, such as TPDDI. Also, signal continuity and timing requirements of some protocols may not be met by time division multiplexing techniques. In particular, timing can be a problem when a random mixture of protocols operating at different speeds are cross connected.

Unacceptable delays between packets may be introduced. Analog routing does not have the same limitations because a dedicated physical connection is implemented between each input and associated output port.

5 The I/O blocks 210, 220 for each port may also include analog or digital circuitry. Appropriate A/D and D/A converters (not shown) are used for connecting to the ports and crosspoint modules as necessary. The cross connect switch 10 is controlled by commands 250 from the
10 central management station 15. The central management station 15 includes a computer controller 17 and a terminal 16. Commands 250 are input into the transmit crosspoint module 230 and receive cross-point module 240 in order to select the specific ports to be
15 interconnected. Commands are also input into the I/O blocks 210, 220 for pair selection, pair termination, and implementation of half duplex control. A set of terminators 211 is selectively connectable to each of the pairs on a port. The terminators can be selectively
20 connected and disconnected from the pair. Termination is required when a system is at the receiving end of a connection. Connection switches 212 are used to connect one of the four differential wire pairs 215-218 to each transmit crosspoint module 230 and receive crosspoint
25 module 240. Compensation amplifiers 213, 214 are used to overcome signal strength losses in the cross connect switch.

Fig. 4 illustrates in more detail the elements of the I/O block 210. The elements of the equipment side
30 I/O block 220 would be identical. The I/O block includes four differential pair input or output connections 215-218. The differential pairs are connected to two sets of switches 321-324, 341-344. Many protocols operate with only two differential pairs, one for transmission and one
35 for reception. Reception switches 321-324 are used to select one of the differential pairs 215-218 as an input to the cross connect switch. Commands 250 from the

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computer controller 17 are used to selectively operate a single switch to connect one of the differential pairs 215-218 to the input line 320 of the I/O block. Similarly, commands from the computer controller 17 are
5 used to selectively operate one of the transmission switches 341-344 to connect one of the differential pairs 215-218 to the transmission line 340 of the I/O block. The reception line 320 and transmission line 340 are selectively connected by switches 371, 372 to input and
10 output ports 381, 382 of the cross-point modules. As noted previously, compensation amplifiers 213, 214 are used to compensate for signal losses in the I/O block. An attenuator 350 is also connected to the reception line in order to equalize signal amplitudes. Auxiliary
15 amplifiers 331-334 can be used to further compensate for losses on the appropriate output selected pair. Terminators 311-314 are selectively connectable to each of the differential pairs 215-218 by commands from the computer controller 17. The reception differential pair
20 can then be selectively terminated as needed. Similarly, the input 382 from the crosspoint modules can be selectively terminated by terminator 375 as needed.

Fig. 4 also illustrates circuitry for implementation of half duplex control. Half duplex protocol uses only
25 one differential pair to communicate. The transmit and receive direction is switched on the single pair as required to accommodate the communications. When there is no communication, the selected port is configured as an input. Thus, the distribution I/O block 210 and the
30 equipment I/O block 220 would both have a port configured as an input. When a communication packet is received at one I/O block, the other I/O block must be reconfigured as an output. When the communication packet is completed, both of the I/O blocks return their ports to
35 input configurations. The port configuration is controlled by a half duplex controller 360 and two line monitors 364, 366. Line monitor 364 is connected to the

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reception line 320 when a line monitor 364 detects an incoming signal, and indicates the signal to the half duplex controller. A second line monitor 366 monitors the transmission line to determine whether a signal has
5 been received from the cross-point module. When a signal is received from the cross-point module the line monitor indicates this receive signal to the half duplex controller 360. The half duplex controller then operates to control the transmission amplifier 331, the reception
10 connection switch 321, and the terminator 311. Upon receipt of a transmission, indicated by line monitor 366, the amplifier 331 is enabled, the terminator 311 is disabled and reception connection switch 321 is disabled. When the transmission ends, the terminator is enabled and
15 the reception switch is again enabled to monitor for receive signals.

Fig. 5 illustrates in greater detail the connections of the half duplex controller 360. The line monitors 364, 366 have inputs for user memory map bits
20 representing a threshold. The line monitor compares the input signal with the threshold to determine whether a signal is being received. An output from the line monitor goes to the half duplex controller 360. The half duplex controller then controls the receive switch 321,
25 sense switch 341, and termination switch 311. The termination switch 311 selectively connects and disconnects the input line from a resistor 315 to ground.

Protocols such as token ring require the generation of a DC phantom current flowing into the pairs being used
30 for interconnection in order to have the connection inserting into the ring. In order to accommodate token ring type protocols, a token ring interface 400 is connected to the pairs of the relevant ports, as illustrated in Fig. 4. The interface detects the
35 presence of a phantom current on the distribution side and regenerates it on the equipment side, and vice versa. When a fault exists on one side, it is detected by the

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circuit and relayed through the cross point switch to the other side. Some analog cross connect switch technologies cannot accommodate large DC currents present on wire pairs as required by some protocols. Couplings
5 across the cross connect switch must be AC and the phantom DC currents have to be relayed by other mechanisms.

Figs. 6A and 6B are schematics of the token ring interface with respect to the equipment side and
10 distribution side, respectively, of the cross connect matrix. These figures also illustrate the connections at the trunk coupling unit and the computer station. However, these portions of the figures are not part of the cross connect switch, but are part of the system into
15 which the cross connect switch is placed. As illustrated in Fig. 6A, on the equipment side, the phantom current must be detected at the receive port. The differential pair of the receive port are connected together by two resistors 415, 417, each having a typical value of 2K
20 ohms ($\pm 1\%$). A resistor, having a value of approximately 50 ohms, and a capacitor, having a value of approximately 0.1 μ F, are connected in parallel from the center point of the two resistors to the midrail 401. The phantom current is detected at the center point of the two
25 resistors 415, 417. On the transmit port, a phantom current supply 402, having a reference of the midrail 401, is selectively connected to the two wires of the transmit pair through resistors 405, 406. The selective connection is made from a signal through resistor 411 to
30 connect the transistor 412 to the reference voltage VEE. When the transistor 412 is turned on, the voltage VEE is connected is through resistor 404 to the base of transistor 403 to connect the phantom current voltage supply 402 to the transmitting port. Resistors 405 and
35 406 typically have values of 2K ohms. Resistors 411 and 404 typically have values of 10K ohms. Each of the wires on the pair also includes a current limiting resistance

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407, 409, 413, 419, and a filtering capacitor 408, 410, 414, 420. The current limiting resistance has a typical value of 2.7 ohms. The filtering capacitances typically have a value of 0.1 μ F.

5 As illustrated in Fig. 6B, the token ring interface on the distribution side operates to detect the phantom current generated by the station. The midrail and the phantom current detector line are connected together through resistance and capacitance 460, 461.

10 The present invention has the capability of operating with a variety of different protocols. Table 1 illustrates different protocols, the speeds at which they operate, and the ports used for transmission and reception.

Protocol	Speed (Mbps)	TX pair	RX pair	special circuit	DC
ISDN S/T	0.192	2	1	pair selection, DC blocking	-48V
AS-400	1	1	1	pair selection, dynamic termination and amplifier switching	-
T1	1.544	3	2	pair selection	-
IBM 3270	2.358	1	1	pair selection, dynamic termination and amplifier switching	-
Token-ring	4/16	2	1	pair selection, phantom current detect and generate, fault detect and generate	7V
Ethernet	10	3	2	pair selection	-
ATM-25	25.6	2 or 3	1 or 4	pair selection	-
T3	44.736	3	4	pair selection	-
TP-DDI	100	3	4	pair selection, high bandwidth	-
Fast-Ethernet	100	3	2	pair selection, high bandwidth	-
RS-422	0-0.1	3	4	pair selection	-
RS-232	0-0.1	3	4	pair selection	-
baseband video	0-6MHz	3	4	pair selection	-

Table 1

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Using the central management station 15, commands are sent from the computer controller 17 to the different I/O blocks in order to indicate the type of protocol to be implemented in that I/O block. Based upon the protocol to be implemented, the I/O block operates in different manners in order to provide the proper functions for the protocol. Indicated in Table 1 are the circuit switch function for each protocol. For all the protocols, the appropriate differential pairs are selected using the switching mechanisms 212, 222. For certain types of protocol, the termination is dynamically controlled using terminators 211, 221. With respect to token ring protocols, as discussed above, a phantom current detection and generation is performed, as well as fault detection and generation. As indicated in Table 1, the various communication protocols operate over different bandwidths. It is important to warrant 0 DB insertion loss over a bandwidth which covers all of the protocols of interest. If the I/O blocks or a cross point modules introduced some amount of insertion loss inside the frequency range of a protocol, it is necessary to compensate for this loss. Wide bandwidth amplifiers are used to overcome the insertion loss.

In addition to selecting the protocols for each I/O block, the central management station 15 also controls the receive cross point module 240 and transmit cross point module 230 in order to connect together appropriate I/O blocks on the distribution side and equipment side of the cross connect switch. The cross connect switch of the present invention allows different protocols to be used simultaneously through the switch without the need of specialized circuitry. Thus, for each port, different protocols can be used based upon the equipment being connected to. Since the protocols and the equipment can be controlled from the central management station, physical changes for interconnecting equipment or

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changing protocols are not required.

Having thus described the embodiments of the invention, various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be part of this disclosure, and are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description is by way of example only and is not intended as limiting. The invention is limited only as defined in the following claims and the equivalents thereto.

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CLAIMS

1. A computer network comprising:
 - a plurality of computer devices each having a local area network interface means for digital communication
 - 5 with other one of said devices according to one of a plurality of protocols;
 - a plurality of local area network hubs;
 - a multi-protocol cross-connect switch for automatically providing a signal path between each of
 - 10 said computer devices and one of said hubs under control of a controller command signal;
 - a plurality of multi-protocol data transmission cables extending between locations for said devices and said cross-connect switch; and
 - 15 a central management controller for generating said command signal.
2. The network as claimed in claim 1, wherein said cross-connect switch includes a plurality of input/output
- 20 blocks.
3. The network as claimed in claim 2, wherein said input/output blocks have a plurality of different protocol configurations settable by said central
- 25 management controller.
4. The network as claimed in claim 1, 2 or 3, wherein said switch is an analog switch.
5. A network interconnection apparatus comprising:
 - at least one cross connect module having a plurality of inputs and a plurality of outputs, the cross connect module selectively connecting inputs to outputs; and
 - a plurality of input/output blocks connected to the
 - 35 inputs and outputs of the cross connect module.
6. The network interconnection apparatus as

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claimed in claim 5, wherein each input/output block comprises:

a block output connected to one of the inputs of the cross connect module;

5 a block input connected to one of the outputs of the cross connect module;

at least one port connected to a corresponding device in the network; and

10 a connection circuit for selectively connecting the block output and block input to the at least one port.

7. The network interconnection apparatus of claim 6, wherein the at least one port includes at least three ports, and wherein the connection circuit selectively
15 connects one of the at least three ports to the block input, and another one of the at least three ports to the block output.

8. The network interconnection apparatus of claim
20 6, further comprising a control circuit, and wherein the connection circuit selectively connects the at least one port and the block input and block output based upon input signals from the control circuit.

25 9. The network interconnection apparatus of claim 8, wherein the inputs and outputs of the cross connect module are selectively connected based upon a signal from the control circuit.

30 10. The network interconnection apparatus of claim 6, wherein the connection circuit includes a bi-directional switch matrix.

11. The network interconnection apparatus of claim
35 6, wherein each of the input/output blocks further includes:

a termination module for selectively terminating the

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at least one port into an appropriate impedance.

12. The network interconnection apparatus of claim 11, wherein the termination module selectively terminates
5 the at least one port when the at least one port is connected to the block output.

13. The network interconnection apparatus of claim 6, wherein each of the input/output blocks further
10 includes:

at least one compensation amplifier, connected between the at least one port and one of the block input and block output, to account for signal attenuation.

14. The network interconnection apparatus of claim 6, wherein the input/output blocks include signal
15 connection circuitry required by each of a plurality of communication protocols.

15. The network interconnection apparatus of claim 6, wherein the input/output block further includes half
20 duplex control circuitry for selectively connecting a single port to the block input and block output to provide bi-directional communication through the single
25 port.

16. The network interconnection apparatus of claim 15, wherein the half duplex control circuitry includes:

30 a line monitor for monitoring the block input to detect a signal received from the cross connect module;

a switch for connecting the block input to the single port when a signal is detected by the line monitor; and

35 a switch for connecting the block output to the single port when a signal is not detected.

17. The network interconnection apparatus of claim

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16, wherein the half duplex control circuitry includes a termination connector for connecting the single port to a termination impedance when the signal is not detected.

5 18. The network interconnection apparatus of claim 16, wherein the half duplex control circuitry includes a second line monitor for monitoring the single port to detect a signal received from the single port.

10 19. The network interconnection apparatus of claim 6, wherein the at least one port on each of two input/output blocks connected through the cross connect module includes two ports, and the apparatus further comprises:

15 a phantom current detector connected to one of the ports of one of the input/output blocks for detecting a first phantom current;

 a phantom current generator connected to one of the ports of the other of the input/output blocks for
20 generating a second phantom current when the first phantom current is detected.

 20. The network interconnection apparatus of claim 19, further comprising:

25 means for transmitting detection of the first phantom current from the one input/output block to the other input/output block through the cross connect module.

30 21. The network interconnection apparatus of claim 19, further comprising:

 means for detecting a line fault on the port of the one input/output block; and

 means for simulating a line fault on the port of the
35 other input/output block.

 22. The network interconnection apparatus of claim

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6, wherein the cross connect module includes a plurality of analog cross connect switches.

23. The network interconnection apparatus of claim 5 22, wherein each of the input/output blocks includes at least one A/D converter connected to the at least one port.

24. The network interconnection apparatus of claim 10 6, wherein the cross connect module includes a plurality digital routing switches.

25. The network interconnection apparatus of claim 15 24, wherein each of the input/output blocks includes at least one A/D converter and at least one D/A converter connected to the at least one port.

26. The network interconnection apparatus as claimed in claim 5, wherein each input/output block 20 includes:

at least one port for transmitting signals from the cross connect module and receiving signals to be transferred to the cross connect module; and

25 a protocol operation circuit, receiving a protocol selection signal indicating one of a plurality of protocols, for transmitting and receiving signals through the at least one port according to the protocol indicated by the protocol selection signal.

30

27. The network interconnection apparatus of claim 26, wherein the protocol operation circuit includes a termination circuit for selectively terminating the at least one port based upon the protocol selection signal.

35

28. The network interconnection apparatus of claim 26, the at least one port includes a plurality of ports,

and wherein the protocol operation circuit includes port selection circuits for selecting at least one of the plurality of ports for receiving signals and transmitting signals.

5

29. The network interconnection apparatus of claim 26, wherein the protocol operation circuit includes means for selectively transmitting signals and receiving signals through a single port at different times.

10

30. The network interconnection apparatus of claim 26, wherein the protocol operation circuit includes:

a phantom current detection circuit for detecting a phantom current based upon the protocol selection signal and generating a phantom current detection signal; and

15

a phantom current generator circuit for generating a phantom current based upon a protocol selection signal and a phantom current detection signal.

20

31. A method of configuring and managing a local area network comprising the steps of:

providing a multi-protocol cross-connect switch;

installing a plurality of multi-protocol data transmission cables extending between locations for computing devices in a building and said cross-connect switch, said computing devices operating according to one of a plurality of protocols;

25

connecting a plurality of local area network hubs each operating according to one of a plurality of protocols to said cross-connect switch;

30

causing said switch to connect each one of said computing devices to a selected one of said hubs;

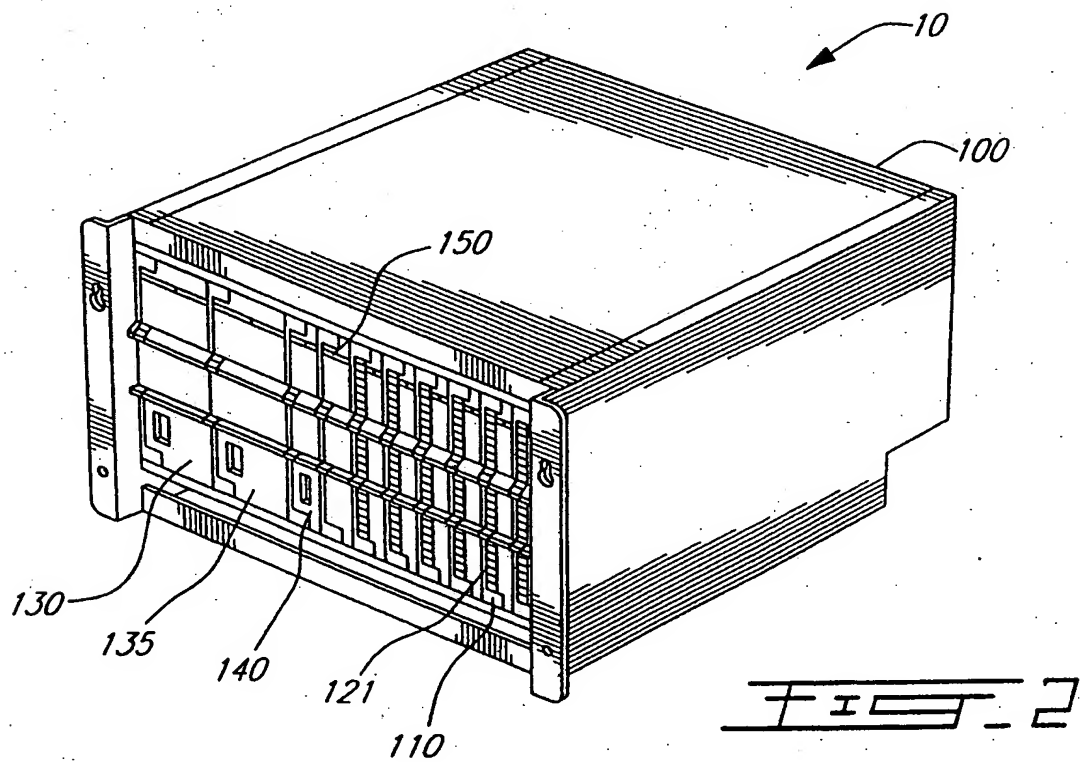
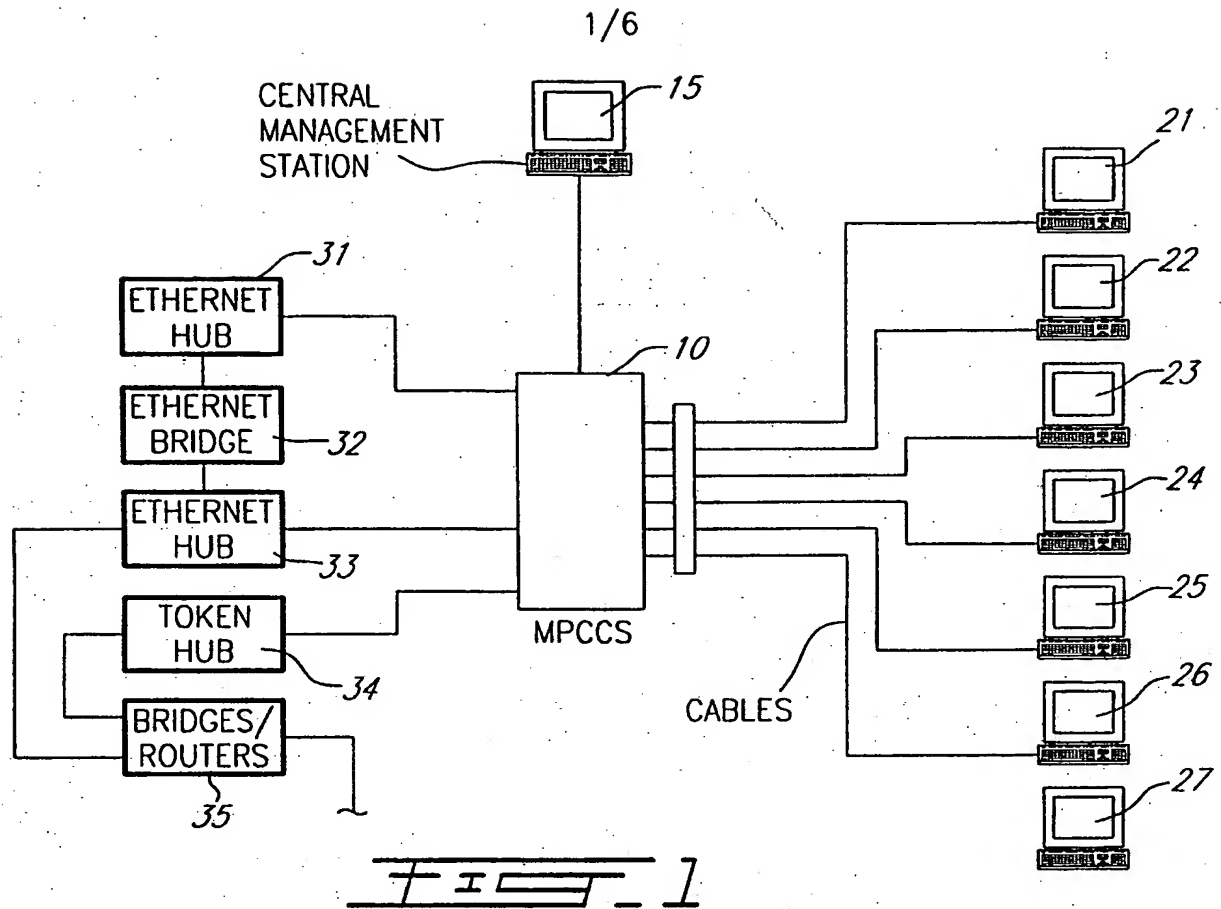
relocating at least one of said computing devices to a different one of said locations; and

35

commanding said switch to connect said at least one of said computing devices relocated to said selected one of said hubs.

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32. The method as claimed in claim 31, wherein said hubs are interconnected by at least one of a bridge and a router.



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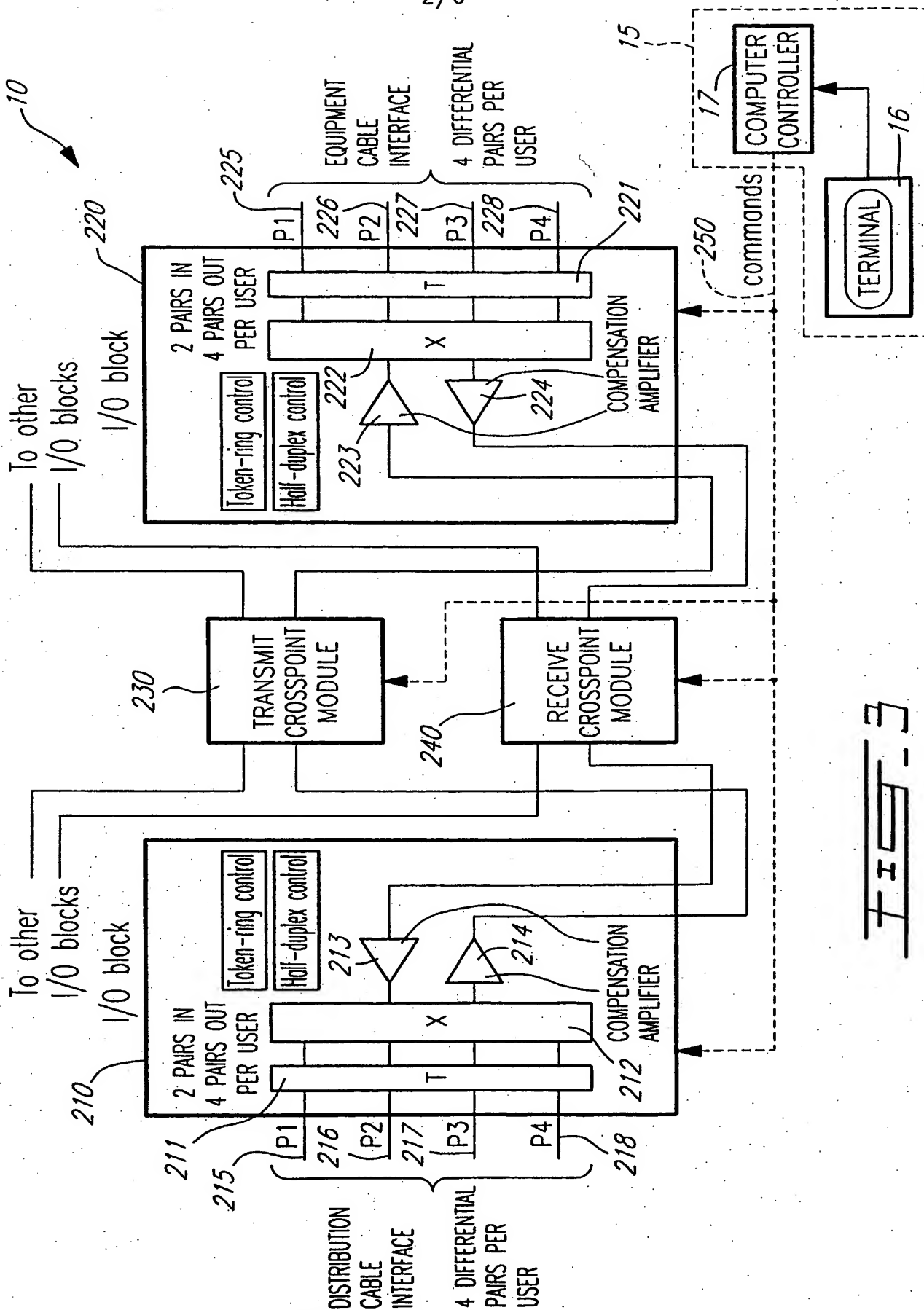
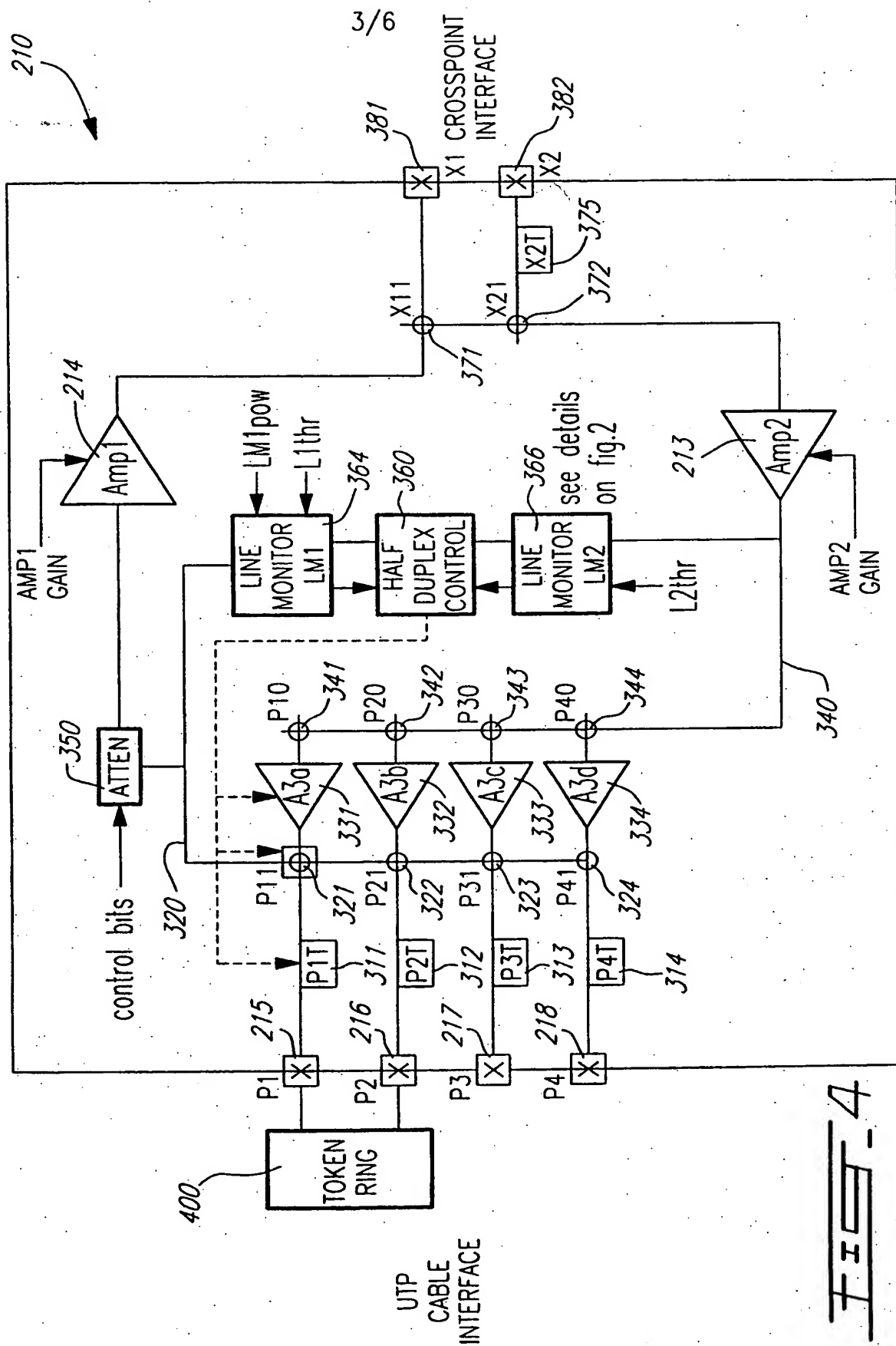


Fig. 3



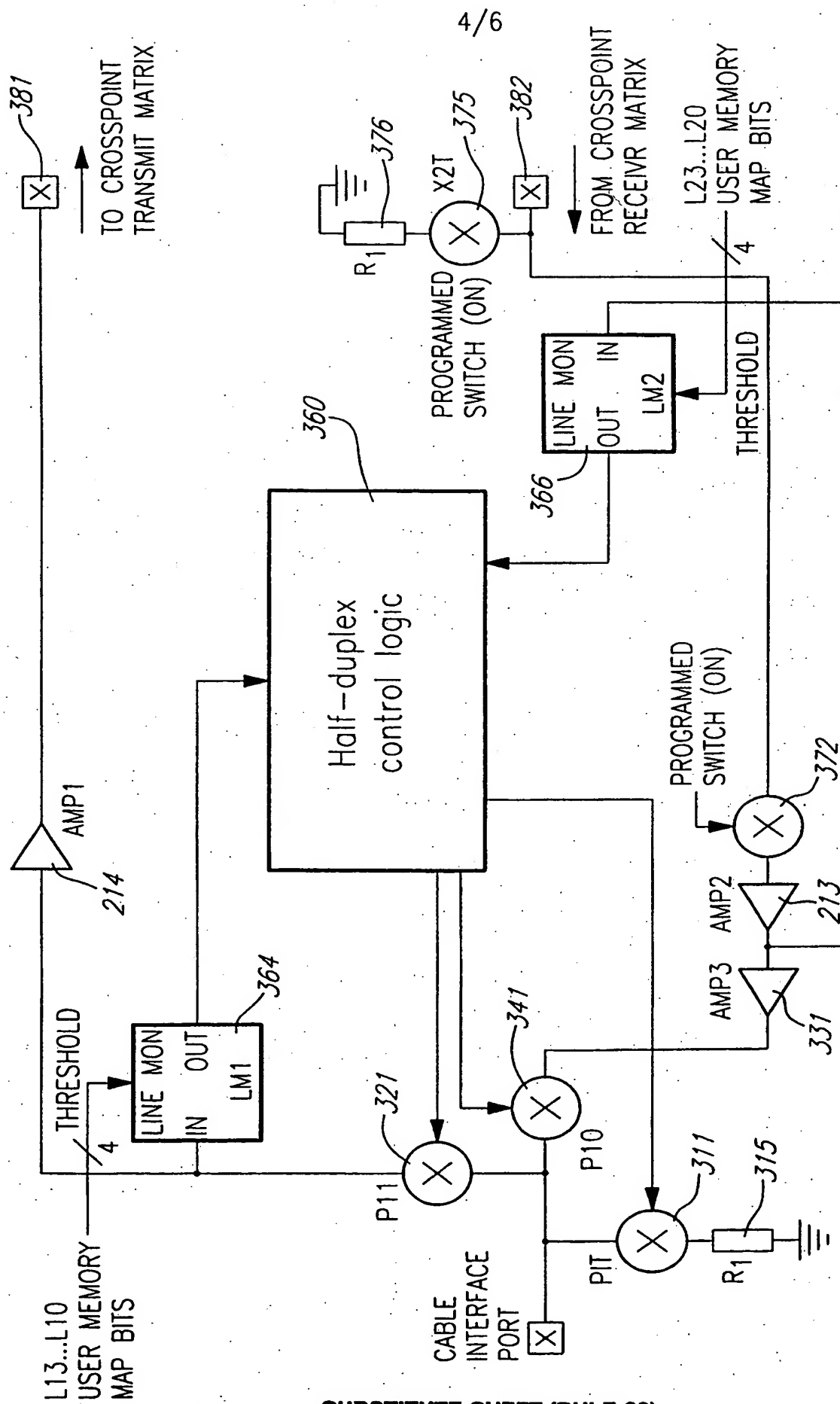
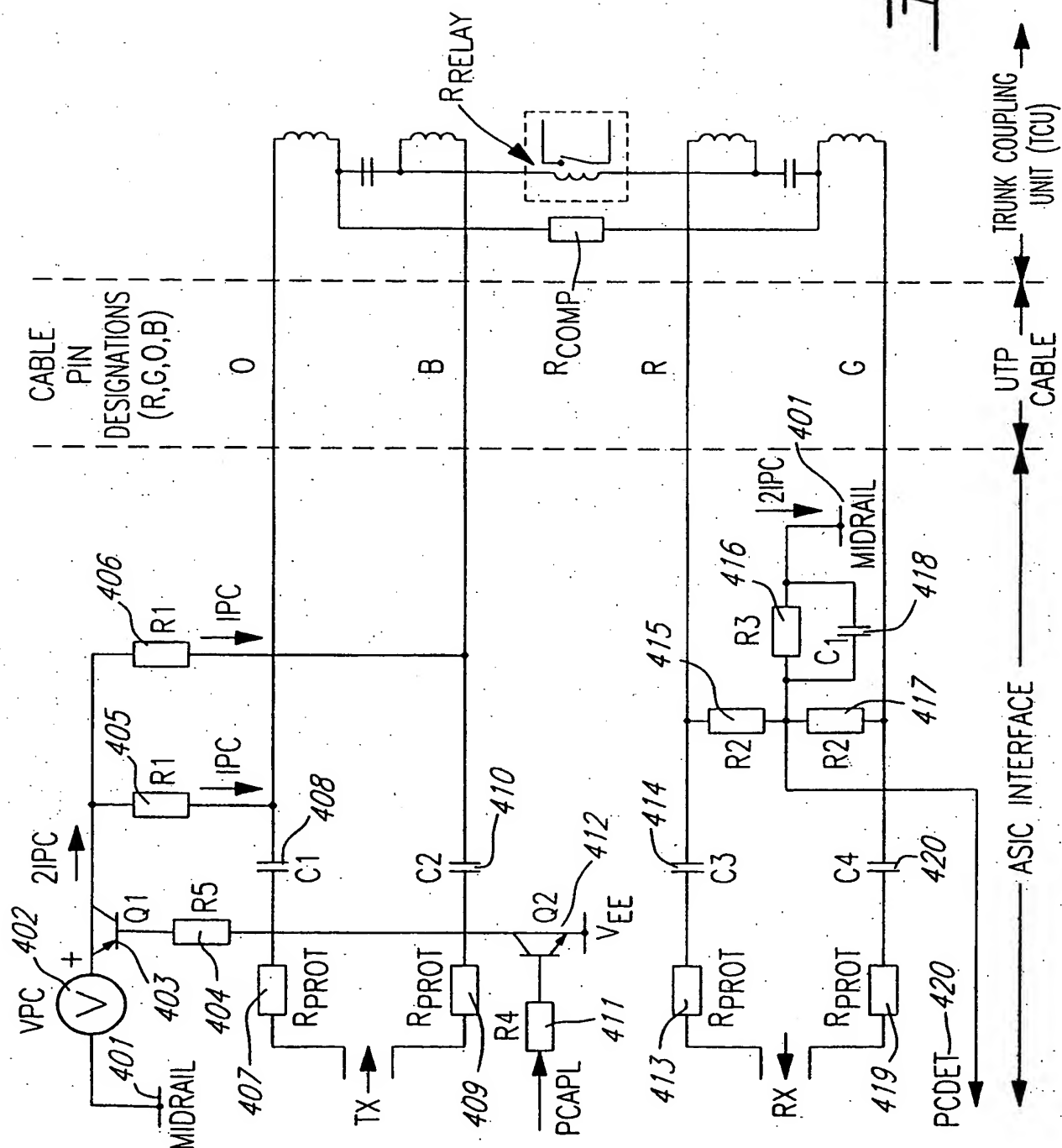
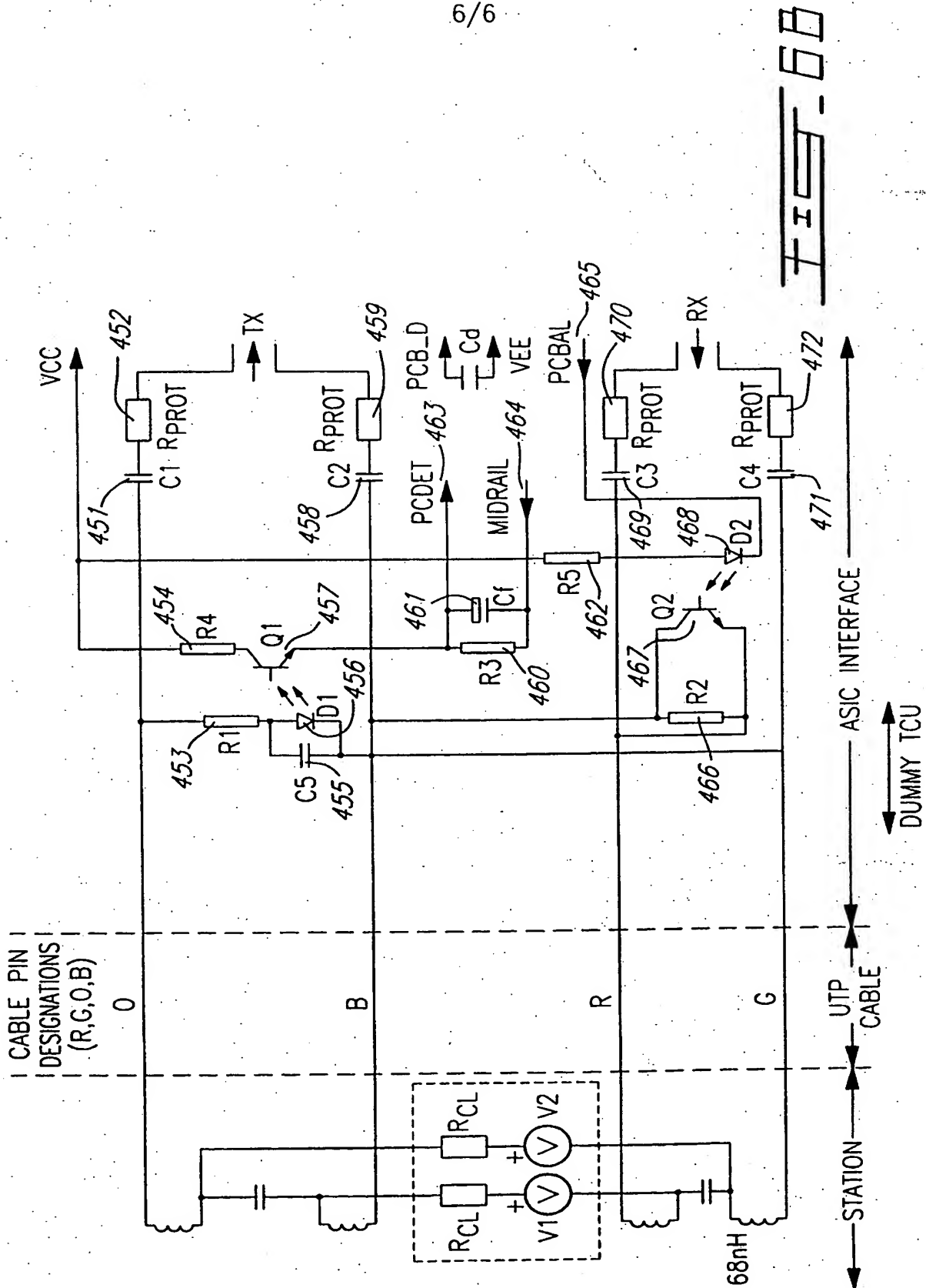


FIG. 5

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/CA 97/00985

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04L12/44 H04L29/06 H04Q1/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 624 043 A (WHITAKER CORP) 9 November 1994	1-6, 10-13, 22, 24, 31, 32
Y	see page 2, column 1, line 1 - page 3, column 2, line 39 see page 3, column 4, line 56 - page 4, column 5, line 47	7-9, 14-21, 26-29
Y	see page 5, column 8, line 19 - page 6, column 9, line 28 see figures 1, 2, 4-6 --- US 5 574 722 A (SLYKHOUSE TOM ET AL) 12 November 1996 see column 1, line 1 - column 2, line 61 see column 3, line 30 - column 4, line 3 see column 4, line 60 - column 7, line 14 --- -/-	7-9, 14, 26-29



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

14 April 1998

Date of mailing of the international search report

21/04/1998

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information on patent family members

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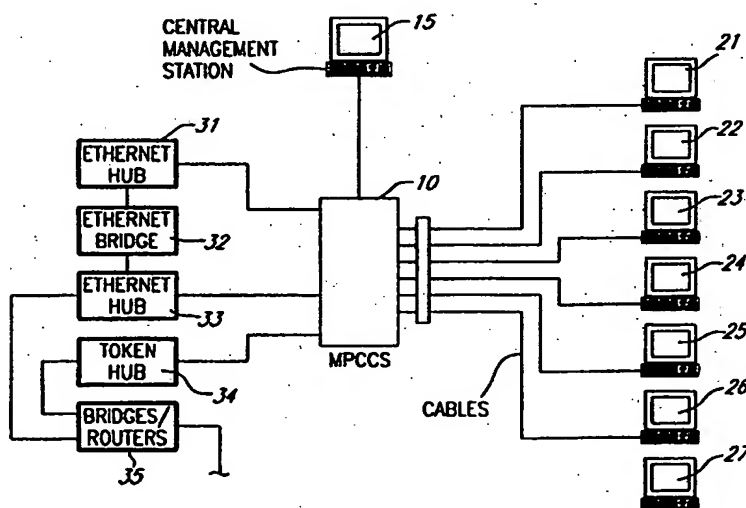
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04L 12/44, 29/06, H04Q 1/14	A1	(11) International Publication Number: WO 98/28883 (43) International Publication Date: 2 July 1998 (02.07.98)
(21) International Application Number: PCT/CA97/00985 (22) International Filing Date: 19 December 1997 (19.12.97) (30) Priority Data: 08/771,979 23 December 1996 (23.12.96) US (71) Applicant: NORDX/CDT., INC. [CA/CA]; 2345 Boulevard des Sources, Pointe-Claire, Quebec H9R 5Z3 (CA). (72) Inventors: LAMARCHE, François; 90 Patrick McGee, Laprairie, Quebec J5R 5L3 (CA). GAUTHIER, John; 2594 Toulouse Street, Mascouche, Quebec J7K 1K2 (CA). (74) Agents: ANGLEHART, James et al.; Swabey Ogilvy Renault, Suite 1600, 1981 McGill College Avenue, Montreal, Quebec H3A 2Y3 (CA).		(81) Designated States: AU, CA, CN, JP, MX, SG, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i> <i>With amended claims.</i> Date of publication of the amended claims: 6 August 1998 (06.08.98)

(54) Title: NETWORK INCLUDING MULTI-PROTOCOL CROSS-CONNECT SWITCH



(57) Abstract

The present invention relates to a cross-connect switch which allows different protocols to be used. The switch is made up of two cross point modules, one for transmission and one for reception. I/O blocks corresponding to each station or network interface are connected to the cross point modules. Each I/O block includes four differential pairs. The I/O block permits selective activation for transmission or reception of any of the four pairs. In addition, half duplex control logic is used to implement protocols using a single differential pair for both transmission and reception. Also a token ring interface is included on the I/O blocks in order to allow detection and generation of phantom DC currents necessary for operation with token rings.

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AMENDED CLAIMS

[received by the International Bureau on 19 June 1998 (19.06.98);
original claims 1-32 replaced by new claims 1-33 (6 pages)]

1. A computer network including a plurality of devices each having a local area network interface which can communicate digitally with another one of the plurality of devices using one of a plurality of protocols, through one of a plurality of local area network hubs, the computer network CHARACTERIZED BY:

a multi-protocol cross-connect switch having a plurality of input/output blocks, each of whose configuration can be changed by a configuration signal from communicating using one of the plurality of protocols to communicating using another of the plurality of protocols, the switch automatically providing a signal path between one of the plurality of devices and one of the local area network hubs responsive to a command signal;

a plurality of multi-protocol data transmission cables connecting the local area network interface of each device to an input/output block; and

a central management controller having an output connected to the switch, the output carrying the configuration signal and the command signal.

2. The network as claimed in claim 1, wherein said cross-connect switch includes a plurality of input/output blocks.

3. The network as claimed in claim 2, wherein said input/output blocks have a plurality of different protocol configurations settable by said central management controller.

4. The network as claimed in claim 1, 2 or 3, wherein said switch is an analog switch.

5. A network interconnection apparatus comprising:
a multi-protocol cross-connect switch having a plurality of inputs and a plurality of outputs, wherein the cross-connect switch can selectively connect inputs to outputs; and
a plurality of input/output blocks which can be configured to communicate using any one of a plurality of protocols, the input/output blocks connected to the inputs and outputs of the switch.

6. The network interconnection apparatus as claimed in claim 5, wherein each input/output block comprises:

- a block output connected to one of the inputs of the cross connect module;
- a block input connected to one of the outputs of the cross connect module;
- 5 at least one port connected to a corresponding device in the network; and
- a connection circuit for selectively connecting the block output and block input to the at least one port.

7. The network interconnection apparatus of claim 6, wherein the at least one port includes at least three ports, and wherein the connection circuit selectively connects one of the at least three ports to the block input, and another one of the at least three ports to the block output.

8. The network interconnection apparatus of claim 6, further comprising a control circuit, and wherein the connection circuit selectively connects the at least one port and the block input and block output based upon input signals from the control circuit.

9. The network interconnection apparatus of claim 8, wherein the inputs and outputs of the cross connect module are selectively connected based upon a signal from the control circuit.

10. The network interconnection apparatus of claim 6, wherein the connection circuit includes a bi-directional switch matrix.

11. The network interconnection apparatus of claim 6, wherein each of the input/output blocks further includes:

- a termination module for selectively terminating the at least one port into an appropriate impedance.

12. The network interconnection apparatus of claim 11, wherein the termination module selectively terminates the at least one port when the at least one port is connected to the block output.

13. The network interconnection apparatus of claim 6, wherein each of the input/output blocks further includes:

at least one compensation amplifier, connected between the at least one port and one of the block input and block output, to account for signal attenuation.

14. The network interconnection apparatus of claim 6, wherein the input/output blocks include signal connection circuitry required by each of a plurality of communication protocols.

15. The network interconnection apparatus of claim 6, wherein the input/output block further includes half duplex control circuitry for selectively connecting a single port to the block input and block output to provide bi-directional communication through the single port.

16. The network interconnection apparatus of claim 15, wherein the half duplex control circuitry includes:

a line monitor for monitoring the block input to detect a signal received from the cross connect module;

a switch for connecting the block input to the single port when a signal is detected by the line monitor; and

a switch for connecting the block output to the single port when a signal is not detected.

17. The network interconnection apparatus of claim 16, wherein the half duplex control circuitry includes a termination connector for connecting the single port to a termination impedance when the signal is not detected.

18. The network interconnection apparatus of claim 16, wherein the half duplex control circuitry includes a second line monitor for monitoring the single port to detect a signal received from the single port.

19. The network interconnection apparatus of claim 6, wherein the at least one port on each of two input/output blocks connected through the cross connect module includes two ports, and the apparatus further comprises:

a phantom current detector connected to one of the ports of one of the input/output blocks for detecting a first phantom current;

a phantom current generator connected to one of the ports of the other of the input/output blocks for generating a second phantom current when the first phantom current is detected.

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20. The network interconnection apparatus of claim 19, further comprising:
means for transmitting detection of the first phantom current from the one input/output block to the other input/output block through the cross connect module.

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21. The network interconnection apparatus of claim 19, further comprising:
means for detecting a line fault on the port of the one input/output block; and
means for simulating a line fault on the port of the other input/output block.

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22. The network interconnection apparatus of claim 6, wherein the cross connect module includes a plurality of analog cross connect switches.

23. The network interconnection apparatus of claim 22, wherein each of the input/output blocks includes at least one A/D converter connected to the at least one port.

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24. The network interconnection apparatus of claim 6, wherein the cross connect module includes a plurality digital routing switches.

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25. The network interconnection apparatus of claim 24, wherein each of the input/output blocks includes at least one A/D converter and at least one D/A converter connected to the at least one port.

26. The network interconnection apparatus as claimed in claim 5, wherein each input/output block includes:

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at least one port for transmitting signals from the cross connect module
and receiving signals to be transferred to the cross connect module; and
a protocol operation circuit, receiving a protocol selection signal indicating one of a plurality of protocols, for transmitting and receiving signals through the at least one port

according to the protocol indicated by the protocol selection signal.

27. The network interconnection apparatus of claim 26, wherein the protocol operation circuit includes a termination circuit for selectively terminating the at least one port based upon the protocol selection signal.

28. The network interconnection apparatus of claim 26, the at least one port includes a plurality of ports, and wherein the protocol operation circuit includes port selection circuits for selecting at least one of the plurality of ports for receiving signals and transmitting signals.

29. The network interconnection apparatus of claim 26, wherein the protocol operation circuit includes means for selectively transmitting signals and receiving signals through a single port at different times.

30. The network interconnection apparatus of claim 26, wherein the protocol operating circuit includes:

a phantom current detection circuit for detecting a phantom current based upon the protocol selection signal and generating a phantom current detection signal; and

a phantom current generator circuit for generating a phantom current based upon a protocol selection signal and a phantom current detection signal.

31. A method of configuring and managing a computer network, comprising steps of: connecting at least one computing device through a multi-protocol cable to a multi-protocol cross-connect switch;

connecting a least one local area network hub through a multi-protocol cable to the switch;

changing a protocol used by the switch to communicate with the computing device or the local area network hub from an unselected one of a plurality of protocols to a selected one of the plurality of protocols; and

connecting the computing device to the local area network hub through the switch using the selected protocol.

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32. The method of claim 31, further comprising steps of:

relocating a computing device to a new location;

connecting the relocated computing device through another multi-protocol cable
to the switch; and

5 commanding the switch to reconnect the computing device to the local area
network hub through the switch using the selected protocol.

33. The method as claimed in claim 31, wherein said hubs are interconnected by at
least one of a bridge and a router.

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